HUGHES
RESEARCH LABORATORIES

Contract No. N00014-87-C-2354

(Competitive Award: $1,093,508)

APPLICATIONS RESEARCH STUDIES OF MICROTUBULES

Monthly Letter Progress Report #34

Period: 12 May 1990 to 15 June 1990

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25 June 1990

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1. General Objectives and Approach

This contract provides the Hughes Research Laboratories (HRL) funding for the first two years of a three year research program to investigate techniques basic to novel applications of lipid microtubules (μTs) for electro-optical, optical, and sensor devices, and to study the feasibility of such device applications. The overall program has two main areas: (1) The study of ordered microtubules in fluids and films, for applications such as variable transmission windows, IR polarizers, and microwave phase shifters; (2) The study of ordered attachment of microtubules to surfaces, for applications such as nonlinear optical devices and acoustic detectors. The emphasis in the second year is on the suspension, orientation and electro-optical properties of metallized microtubules in fluids and polymers, especially in regard to potential applications as radar shutters, lenses, and phase shifters. Techniques for controlling the orientation and attachment of microtubules to surfaces is also being studied in regard to acoustical detector applications.

2. Work In The Thirty-fourth Month

In this month we worked in the following areas on μTs: (1) studies on the microwave phase modulation of metallized μTs in liquid crystals as a function of μT concentration.

- We completed studies on μT concentration effects on microwave phase modulation at 30 GHz with LC/μT composites. Studies on 0.3 and 0.6 wt.% of nickel-coated μTs in ROTN-404 were completed. This included phase shift measurements as a function of the composite pathlength in the waveguide test cell, using magnetic field alignment of the composite to determine phase shift and birefringence. The results of these phase shift measurements are shown in the attached Figure 1, indicating that the composite with 0.6 wt.% μTs has a high birefringence of 0.28, which is about twice that of the LC alone. The calculated values of birefringence versus μT concentration are shown for this liquid crystal composite in Figure 2, in comparison with the birefringent values previously determined for μTs in paraffin wax oil. The birefringence of this composite is about 0.15 or more higher than the birefringence of the paraffin wax oil dispersion at the same μT concentrations. Also, the slope of the birefringence versus concentration line is steeper in the LC than in the isotropic oil, indicating a birefringent enhancement effect of combining μTs and LCs.

3. Plans For Next Month

Next month we plan to study the 94 GHz microwave phase shift behavior of metallized μTs dispersed in LC hosts when switching between orthogonal H-fields. We also plan to complete a revised patent application on "Liquid Crystal Based Composite Material Having Enhanced Microwave Birefringence", and to complete our final report on the first two years worth of funding on this contract.

4. Project Status

Total funds expended through this period were about $899.3K at the manufacturing level (corresponding to about $1069.4K sales level). The attached graph shows our estimated sales-level expenditures (since January 1989) versus the proposed completion date of 11 July 1990 for the final report of the second year of the contract.

Figure 1

MICROWAVE (30 GHz) BIREFRINGENCE PHASE SHIFT OF MICROTUBULES IN A LIQUID CRYSTAL HOST

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9029-04-05

Ni-COATED MICROTUBULES; 0.8 μm DIA, ~10 μm LENGTH; H-FIELD ALIGNMENT

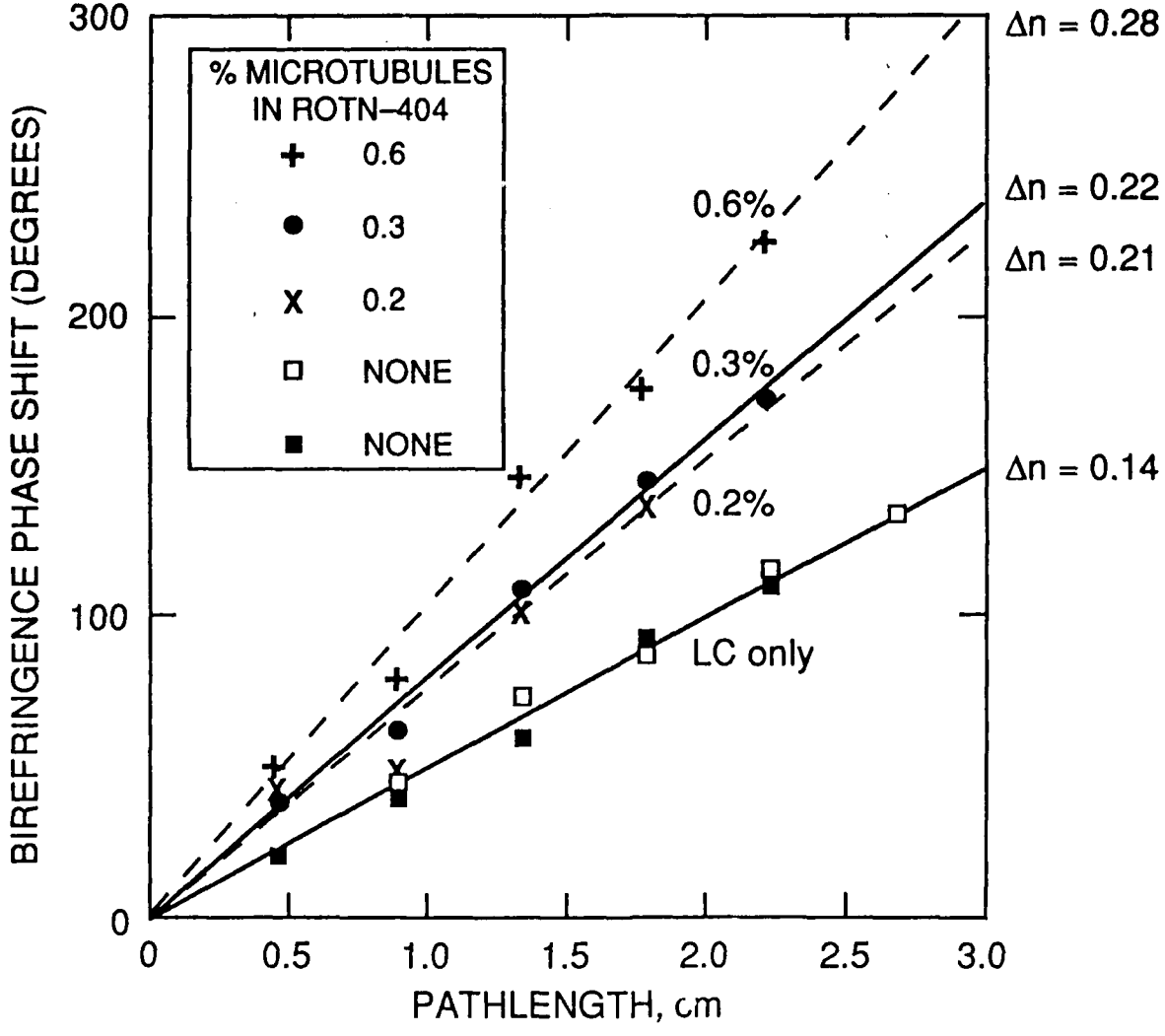

Figure 2

MICROWAVE (30 GHz) BIREFRINGENCE OF MICROTUBULE DISPERSIONS, USING MAGNETIC FIELD ALIGNMENT

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Ni –COATED MICROTUBULES; O.8 μm DIA, ~10 μm LENGTH

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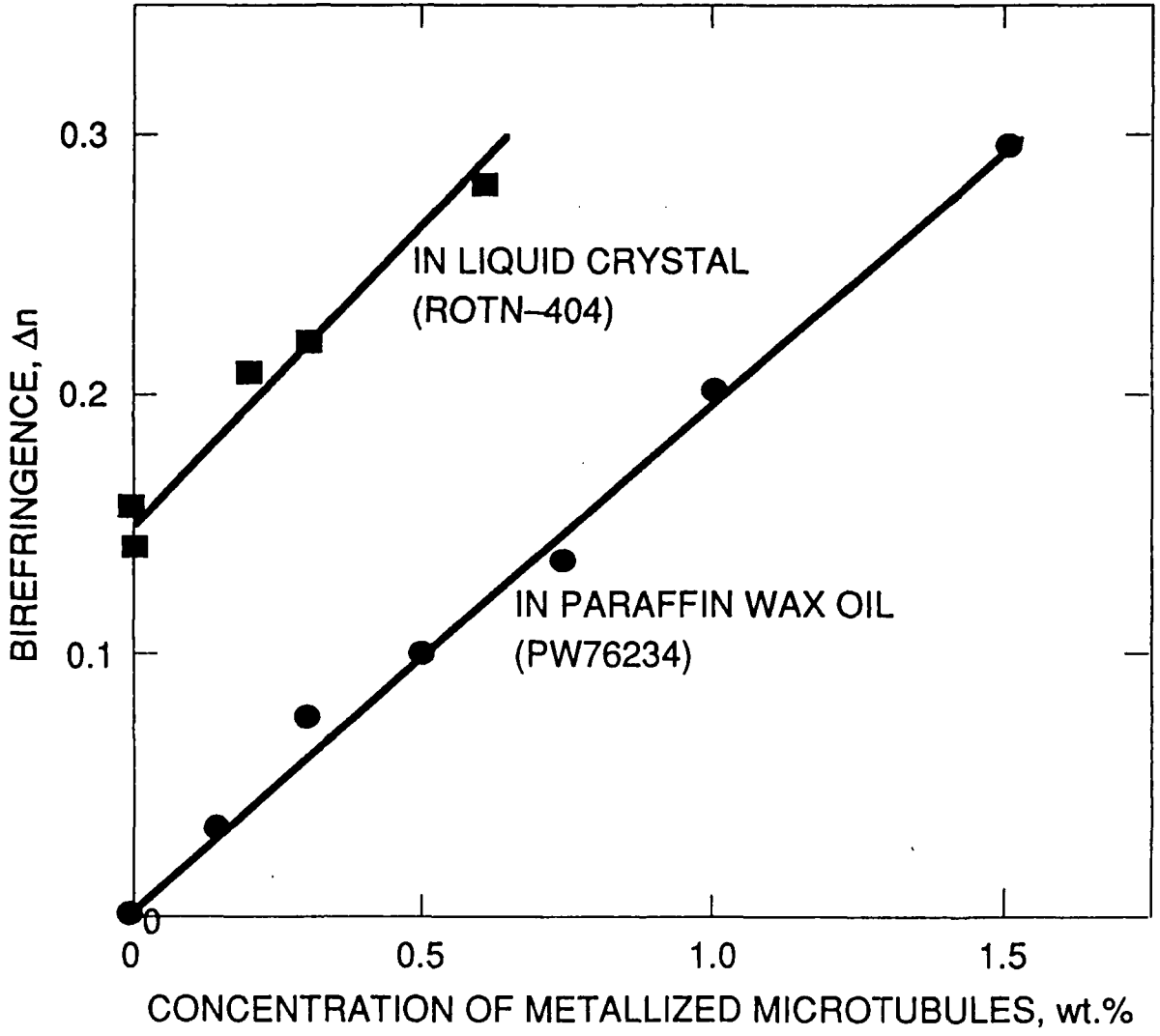

CONTRACT N00014-87-C-2354 SALES LEVEL EXPENDITURES